PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2003-269124

(43)Date of publication of application : 25.09.2003

(51)Int.Cl. F01L 13/00
F01L 1/34
F02D 13/02

(21)Application number : 2002-071226

(22)Date of filing : 15.03.2002

(71)Applicant : NISSAN MOTOR CO LTD

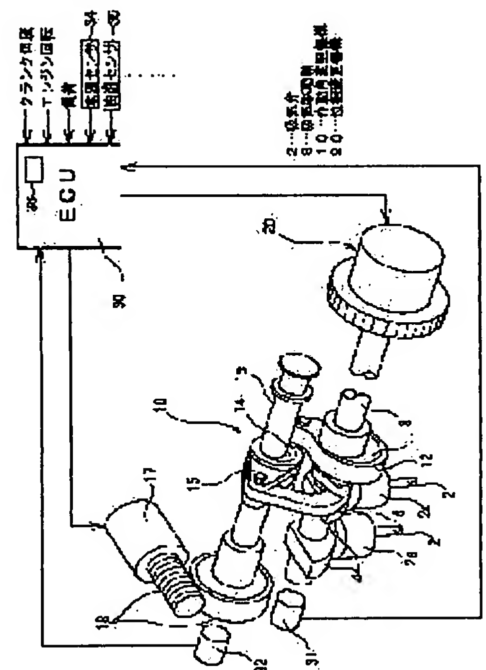
(72)Inventor : MIURA SO

(54) VARIABLE VALVE DEVICE FOR INTERNAL COMBUSTION ENGINE

(57)Abstract:

PROBLEM TO BE SOLVED: To solve the problem that it is difficult to start an engine well because of high friction of the engine resulting from high viscosity of an engine oil at an extremely low temperature further lower than the temperature of the engine when cooled.

SOLUTION: This variable valve device comprises an operating angle changing mechanism 10 for changing an inlet operating angle of an inlet valve, a phase changing mechanism 20 for changing an inlet center phase, and means 36 for estimating the temperature of the engine. In a region of extremely low loading including idling, the inlet operating angle at the extremely low temperature is at least about 180° CA larger than the inlet operating angle with the engine cooled and the inlet center phase is about 90° ATDC.



LEGAL STATUS

[Date of request for examination] 27.06.2003

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]	
[Patent number]	3912147
[Date of registration]	09.02.2007
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

CLAIMS

[Claim(s)]
[Claim 1] In the adjustable moving valve mechanism of the internal combustion engine which has the actuation angle modification device in which the inhalation-of-air actuation angle of an inlet valve can be changed, the phase modification device in which the inhalation-of-air core phase of the above-mentioned inhalation-of-air actuation angle can be changed, and an engine temperature presumption means to presume engine temperature The adjustable moving valve mechanism of the internal combustion engine characterized by making the inhalation-of-air actuation angle at the time of very low temperature with the above-mentioned engine temperature still lower than the time of a cold machine at least larger than the inhalation-of-air actuation angle at the time of the above-mentioned cold machine in the super-low load region which contains an idle at least.
[Claim 2] The adjustable moving valve mechanism of the internal combustion engine according to claim 1 characterized by setting about 180-degreeCA and the above-mentioned inhalation-of-air core phase as about 90-degreeATDC for the above-mentioned inhalation-of-air actuation angle at the time of the above-mentioned very low temperature in the above-mentioned super-low load region.
[Claim 3] The adjustable moving valve mechanism of the internal combustion engine according to claim 2 characterized by carrying out the angle of delay of the inhalation-of-air core phase at the time of the above-mentioned cold machine rather than the inhalation-of-air core phase at the time of the above-mentioned very low temperature in the above-mentioned super-low load region.
[Claim 4] The adjustable moving valve mechanism of the internal combustion engine according to claim 1 to 3 characterized by carrying out the tooth lead angle of the inhalation-of-air core phase after the above-mentioned warming-up rather than the inhalation-of-air core phase at the time of the above-mentioned cold machine in the above-mentioned super-low load region.
[Claim 5] The adjustable moving valve mechanism of the internal combustion engine according to claim 1 to 4 characterized by setting about 90-degreeCA and the above-mentioned inhalation-of-air core phase as about 180-degreeATDC for the above-mentioned inhalation-of-air actuation angle at the time of the above-mentioned cold machine in the above-mentioned super-low load region.
[Claim 6] The adjustable moving valve mechanism of the internal combustion engine according to claim 1 to 5 characterized by driving preferentially either an actuation angle modification device or a phase modification device based on either [at least] an engine rotational frequency or engine temperature at the time of engine acceleration.
[Claim 7] The adjustable moving valve mechanism of the internal combustion engine according to claim 6 characterized by driving a phase modification device preferentially at the time of the above-mentioned cold machine at the time of the acceleration from a super-low load and super-low revolution region including the time of engine start up, and driving an actuation angle modification device preferentially after warming-up.
[Claim 8] The adjustable moving valve mechanism of the internal combustion engine according to claim 6 or 7 characterized by driving a phase modification device preferentially in a super-low revolution region, and driving an actuation angle modification device preferentially in a low revolution region at the time of the acceleration from the super-low load region at the time of the above-mentioned cold machine.
[Claim 9] The adjustable moving valve mechanism of the internal combustion engine according to claim 1 to 8 characterized by either [at least] the above-mentioned phase modification device or an

actuation angle modification device being electromotive.
[Claim 10] The adjustable moving valve mechanism of the internal combustion engine according to claim 1 to 9 characterized by making the actuation angle of the inlet valve in the above-mentioned super-low load region smaller than the warming-up back in the time of a cold machine.
[Claim 11] the above-mentioned actuation angle modification device -- the above-mentioned inhalation-of-air driving shaft -- relativity -- it being attached outside pivotable and an inlet valve with the splash cam which carries out closing motion actuation the actuation cam prepared by carrying out eccentricity to the above-mentioned inhalation-of-air driving shaft, and this actuation cam -- relativity -- with the ring-like link attached outside pivotable the above-mentioned inhalation-of-air driving shaft, the control axis arranged in parallel, the control cam prepared in this control axis by carrying out eccentricity, and this control cam -- relativity, while being attached outside pivotable The adjustable moving valve mechanism of the internal combustion engine according to claim 1 to 10 characterized by having the rod-like link where the end was connected with the rocker arm connected with the above-mentioned ring-like link, and the other end and the above-mentioned splash cam of this rocker arm.
[Claim 12] A means to detect angle of rotation of the above-mentioned inhalation-of-air driving shaft, and a phase detection means to detect the real core phase of the actuation angle of an inlet valve based on angle of rotation of this inhalation-of-air driving shaft, A means to detect angle of rotation of the above-mentioned control axis, and an actuation angle detection means to detect the real actuation angle of an inlet valve based on angle of rotation of this control axis, **** and it doubles with the timing as which a real core phase is detected by the above-mentioned phase detection means. The adjustable moving valve mechanism of the internal combustion engine according to claim 11 characterized by detecting a real actuation angle with the above-mentioned actuation angle detection means, and setting up the desired value of the above-mentioned inhalation-of-air actuation angle and an inhalation-of-air core phase based on these real core phase and a real actuation angle.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the adjustable moving valve mechanism of the internal combustion engine which has the both sides of the actuation angle modification device in which the actuation angle (inhalation-of-air actuation angle) of an inlet valve can be changed, the phase modification device in which the main phase (inhalation-of-air core phase) of the actuation angle of an inlet valve can be changed, and **.
[0002]
[Description of the Prior Art] In order to attain improvement in an internal combustion engine's output and fuel consumption, and reduction-ization of exhaust air emission, the various adjustable moving valve mechanisms into which the closing motion property (valve-lift property) of an inlet valve or an exhaust valve is changed are proposed conventionally. For example, the adjustable moving valve mechanism which used together the valve timing modification device which can be changed continuously is indicated [phase / of the amount modification device of valve lifts which can be changed into two steps, and the actuation angle of an inlet valve / main] by JP,2000-18056,A in the amount of valve lifts and actuation angle of an inlet valve.
[0003]
[Problem(s) to be Solved by the Invention] It is better to make an inhalation-of-air actuation angle small in such an adjustable moving valve mechanism in a super-low load region including an idle in respect of aiming at improvement in fuel consumption, and lowering of exhaust air emission. However, at the time of very low temperature to which engine temperature falls in a cold district etc. exceeding -20 degrees C, it mainly originates in the increment in the viscosity of an engine oil, and an engine's friction becomes very high. Therefore, it is the above-mentioned super-low load region, sufficient engine torque to resist the above-mentioned engine friction and put an engine into operation, if an inhalation-of-air actuation angle is made small in the situation at the time of very low temperature as temporarily mentioned above cannot be acquired, but there is a possibility of causing lowering of engine startability. This invention is made in view of such a technical problem.
[0004]
[Means for Solving the Problem] The adjustable moving valve mechanism of the internal combustion engine concerning this invention has the actuation angle modification device in which the inhalation-of-air actuation angle of an inlet valve can be changed, the phase modification device in which the inhalation-of-air core phase of the above-mentioned inhalation-of-air actuation angle can be changed, and an engine temperature presumption means to presume engine temperature. And in the super-low load region which contains an idle at least, the inhalation-of-air actuation angle at the time of very low temperature with the above-mentioned engine temperature still lower than the time of a cold machine is made at least larger than the inhalation-of-air actuation angle at the time of the above-mentioned cold machine. Typically, about 180-degreeCA (whenever [crank angle]) and the above-mentioned inhalation-of-air core phase are set as about 90-degreeATDC (include angle after a top dead center) for the above-mentioned inhalation-of-air actuation angle at the time of the above-mentioned very low temperature in the above-mentioned super-low load region.
[0005] Moreover, even if it is at the acceleration time from the same load region, by carrying out change-over control of the modification device driven preferentially (previously) based on an engine

rotational frequency or engine temperature, depression of the torque at the time of acceleration is prevented, and it becomes possible to aim at improvement in engine performance.

[0006]

[Effect of the Invention] According to this invention, according to engine temperature, an inhalation-of-air actuation angle is appropriately adjusted to a super-low load region. That is, while securing good engine startability by enlarging an inhalation-of-air actuation angle relatively at the time of very low temperature, at the time of situations other than the time of the very low temperature which includes the time of a cold machine at least, improvement of exhaust air emission and improvement in fuel consumption can be aimed at by making an inhalation-of-air actuation angle small relatively.

[0007]

[Embodiment of the Invention] Hereafter, the gestalt of desirable operation of this invention is explained to a detail with reference to a drawing.

[0008] Drawing 1 shows the adjustable moving valve mechanism concerning 1 operation gestalt of this invention. The inlet valve 2 of a couple was formed in each cylinder, and the hollow-like inhalation-of-air driving shaft 3 has extended in the direction of a cylinder train above these inlet valves 2. the splash cam 4 which carries out closing motion actuation of the inlet valve 2 in contact with valve-lifter 2a of an inlet valve 2 at the inhalation-of-air driving shaft 3 -- relativity -- it is attached outside pivotable.

[0009] Between the inhalation-of-air driving shaft 3 and the splash cam 4, the electromotive actuation angle modification device 10 in which the inhalation-of-air actuation angle and the amount of valve lifts which are the actuation angle of an inlet valve 2 are changed continuously is established. The electromotive phase modification device 20 in which the inhalation-of-air core phase which is a main phase of the above-mentioned inhalation-of-air actuation angle is changed continuously is arranged in the end section of the inhalation-of-air driving shaft 3 by changing the phase of the inhalation-of-air driving shaft 3 over the crankshaft outside drawing.

[0010] The circular actuation cam 11 which carries out eccentricity to the inhalation-of-air driving shaft 3, and is prepared fixed as the actuation angle modification device 10 is shown in drawing 1 and drawing 2 , this actuation cam 11 -- relativity -- with the ring-like link 12 attached outside pivotable the inhalation-of-air driving shaft 3, the control axis 13 prolonged in the direction of a cylinder train in abbreviation parallel, the circular control cam 14 which carried out eccentricity to this control axis 13, and was prepared fixed, and this control cam 14 -- relativity, while being attached outside pivotable It has the rod-like link 16 where the end was connected with the rocker arm 15 connected at the head of the ring-like link 12, and the other end and the splash cam 4 of this rocker arm 15. With the electric actuator 17, through the gear train 18, a control axis 13 is in a predetermined control range, and revolution actuation is carried out.

[0011] If a crankshaft is interlocked with and the inhalation-of-air driving shaft 3 rotates by the above-mentioned configuration, while the ring-like link 12 will carry out advancing-side-by-side migration mostly through the actuation cam 11, a rocker arm 15 rocks to the circumference of the axial center of the control cam 14, the splash cam 4 rocks through the rod-like link 16, and closing motion actuation of the inlet valve 2 is carried out. Moreover, by changing angle of rotation of a control axis 13, the axial center location of the control cam 14 used as the center of oscillation of a rocker arm 15 changes, and the position of the splash cam 4 changes. Thereby, while the inhalation-of-air core phase has been abbreviation regularity, an inhalation-of-air actuation angle and the amount of valve lifts change continuously.

[0012] Since the joining segment of each part material for a part for bearing of the actuation cam 11 or bearing, such as the control cam 14, etc. serves as field contact, lubrication tends to perform such an actuation angle modification device 10, and it is excellent in endurance and dependability. Moreover, while excelling in control precision as compared with a configuration which supports a splash cam by another pivot which is different in the inhalation-of-air driving shaft 3 since the splash cam 4 which drives an inlet valve 2 is arranged on the inhalation-of-air driving shaft 3 and the same axle for example, equipment itself will become compact, and it is excellent and is in engine loading nature. It can apply to especially the valve gear system of direct-acting, without adding modification of a big layout. Furthermore, since it does not dare need energization means, such as a return spring, the friction of a valve gear system is also controlled low.

[0013] ECU30 as an engine control unit performs general engine control of fuel-injection control, ignition-timing control, etc. whenever [crank-angle / which is detected or presumed] based on engine service conditions, such as an engine rotational frequency, a load, and engine temperature, from various sensors besides the include angle of the inhalation-of-air driving shaft 3 detected from the include-angle detection sensors 31 and 32, and a control axis 13 etc., and also changes and controls the inhalation-of-air actuation angle and the inhalation-of-air core phase of an inlet valve 2 to mention later. Moreover, ECU30 includes an engine temperature presumption means 36 to presume engine temperature (oil water temperature), at least based on one side of oil-temperature ** detected by the cooling water temperature detected by the well-known coolant temperature sensor 34, and the well-known oil-temperature sensor 35, and can judge to accuracy whether it is after the time of a cold machine, or warming-up based on this engine temperature at the time of an engine's standby mentioned later, i.e., very low temperature.
[0014] Drawing 3 shows the electromotive phase modification device 20. The 1st body of revolution 21 which this phase modification device 20 is fixed to the cam sprocket 25 rotated synchronizing with a crankshaft, and is rotated in one with this cam sprocket 25, It is fixed to the end of the inhalation-of-air driving shaft 3 by bolt 22a, and has this inhalation-of-air driving shaft 3, the 2nd body of revolution 22 rotated in one, and the tubed medium gear 23 which meshes by the helical spline 26 to the inner skin of the 1st body of revolution 21, and the peripheral face of the 2nd body of revolution 22. The drum 27 is connected with this medium gear 23 through the three-article screw 28, it twists between this drum 27 and the medium gear 23, and the spring 29 is infixed. the medium gear 23 is energized in the direction of the angle of delay (left of drawing 3) with the torsion spring 29 -- having -- **** -- electromagnetism -- if an electrical potential difference is impressed to a retarder 24 and magnetism is generated, it will be moved in the direction of a tooth lead angle (right of drawing 3) through a drum 27 and the three-article screw 28. According to the shaft-orientations location of this medium gear 23, the relative topology of body of revolution 21 and 22 changes, and the phase of the inhalation-of-air driving shaft 3 over a crankshaft changes. the above-mentioned electromagnetism -- according to engine operational status, actuation control of the retarder 24 is carried out by the control signal from ECU30 mentioned above.
[0015] Drawing 4 is the flow chart which shows setting out and the control flow of the inhalation-of-air actuation angle in the time of the engine start up which makes the important section of this operation gestalt, and a super-low load region, and an inhalation-of-air core phase, and this routine is performed by ECU30. In S(step) 1, if judged with it being the super-low load region which it judges that is at the engine start-up time, or contains an idle by the idle judging of S2, it will progress to S3 and the engine temperature presumed by the engine temperature presumption means 36 will be read. The table and map corresponding to drawing 5 (a) and drawing 6 (b) (or (c)) which are mentioned later are beforehand memorized by the memory of ECU30, and the desired value of an inhalation-of-air actuation angle and an inhalation-of-air core phase is calculated by referring to these tables and maps in S4 in it based on the above-mentioned engine temperature. the control signal corresponding to such desired value at S5 -- the electric actuator 17 of the actuation angle modification device 10, and the electromagnetism of the phase modification device 20 -- it outputs to a retarder 24. According to these control signals, an inhalation-of-air actuation angle and an inhalation-of-air core phase are adjusted independently mutually. If the idle judging of S2 is denied, setting out and control of the inhalation-of-air actuation angle according to an engine rotational frequency and an engine load and an inhalation-of-air core phase will be performed by other routines which progress to S6 and are not illustrated.
[0016] Drawing 5 - drawing 7 show the inhalation-of-air valve-lift property over engine temperature in a super-low load region including the time of the above-mentioned engine start up, or an idle, drawing 5 (a) shows the property of an inhalation-of-air actuation angle, and drawing 6 (b) shows the property of an inhalation-of-air core phase. In addition, in this description, as everyone knows, it is in the condition of the ordinary temperature before warming-up at "the time of a cold machine", and it is a time of engine temperature being about 20 degrees C typically. In a cold district etc., at "the time of very low temperature", engine temperature is still lower than the time of the usual cold machine, and it is typically at the time of -20 degrees C or less.
[0017] Since the viscosity of the engine oil as a lubricating oil is high and an engine's friction

becomes large as compared with the time of a cold machine, at the time of very low temperature, it is necessary to resist this friction and to generate the big engine torque which can maintain idle rpm at least. So, with this operation gestalt, about 180-degreeCA and inhalation-of-air core phase 40b is set as about 90-degreeATDC for inhalation-of-air actuation angle 40a at the time of such very low temperature. That is, IVO of the inhalation-of-air valve-lift property 40 is carried out near the TDC, and IVC is carried out near the BDC. This will be in the condition which the inlet valve opened the neither more nor less corresponding to the intake stroke, i.e., the condition that there is almost neither a valve overlap nor minus overlap, and sufficient engine torque which resists the above-mentioned friction and can maintain idle rpm can be generated. Therefore, though it is in a very-low-temperature condition, good engine startability can be secured and a quick warm-up can be performed.

[0018] About 80 degrees - 100 degreeCA which is the minimum actuation angle about inhalation-of-air actuation angle 42a at the time of a cold machine, 180-degreeATDC which it is preferably referred to as 90-degreeCA, and is the maximum angle-of-delay phase about inhalation-of-air core phase 42b, That is, by setting up near the BDC, carrying out the angle of delay of the IVO of the inhalation-of-air valve-lift property 42 more nearly substantially than TDC, and expanding the retard limitation of ignition timing, lifting of an exhaust-gas temperature is promoted, the heating up time of a catalyst is shortened, and an improvement of exhaust air emission is aimed at. Moreover, by minimization of an inhalation-of-air actuation angle, controlling the friction of a valve gear system to the minimum, gas floating is strengthened and atomization of a fuel is promoted.

[0019] After warming-up, the tooth lead angle of the inhalation-of-air core phase 44b is carried out rather than the time of a cold machine, a pumping loss is reduced as compared with the time of a cold machine, using inhalation-of-air actuation angle 44a as the same minimum actuation angle as the time of a cold machine, and an improvement of fuel consumption is aimed at.

[0020] While making small gradually inhalation-of-air actuation angle 41a with lifting of engine temperature, the angle of delay of the inhalation-of-air core phase 41b is gradually carried out to the transition stage from the time of very low temperature to the time of a cold machine. Moreover, the tooth lead angle of the inhalation-of-air core phase 43b is gradually carried out to the transition stage from the time of a cold machine to the warming-up back with lifting of engine temperature. It follows, for example, an engine is put into operation at the time of very low temperature, and an inhalation-of-air actuation angle and an inhalation-of-air core phase can be smoothly changed to a property advantageous to exhaust air emission or fuel consumption with lifting of engine temperature, securing good engine startability, when continuing idle operation until warming up is completed.

[0021] The example of setting out of the inhalation-of-air core phase shown in drawing 6 (b) mentioned above is suitable when the electromotive phase modification device 20 in which an adjustable amount can be set up greatly enough as if excelled in responsibility is used, as shown in drawing 3 . On the other hand, the example of setting out of the inhalation-of-air core phase shown in drawing 6 (c) is compared electromotive [the above], and although responsibility and an adjustable amount are inferior, when the phase modification device of the advantageous hydraulic-drive type in cost is used, they are suitable.

[0022] By setting out of drawing 6 (c), it differs from setting out of drawing 6 (b) at the point which makes set point 42c of the inhalation-of-air core phase at the time of a cold machine equal to set point 44c after warming-up. The set points 40c and 44c after the time of very low temperature and warming-up are the same as the set points 40b and 44b of drawing 6 (b). It is not necessary to change an inhalation-of-air core phase and, and, according to setting out of drawing 6 (c), amount of modification deltaD of an inhalation-of-air core phase ends very few in the transition stage from the time of a cold machine to the warming-up back also in the transition stage from the time of very low temperature to the time of a cold machine. For this reason, although an improvement of the exhaust air emission by angle-of-delay-izing with a large inhalation-of-air core phase etc. cannot be aimed at as compared with the example of setting out of above-mentioned drawing 6 (b) at the time of a cold machine, it becomes possible to change an inhalation-of-air core phase appropriately according to lifting of engine temperature also at the time of the engine start up from the time of very low temperature, securing good engine startability, since there is little modification of an inhalation-of-

air core phase and it ends.
[0023] Drawing 8 shows the example of 1 setting out of the inhalation-of-air actuation angle in various operational status, and an inhalation-of-air core phase. In addition, the value of the inhalation-of-air core phases P1-P5 mentioned later has the relation of P1<P2<P3<P4<P5, when a tooth-lead-angle side is made forward.
[0024] First, the valve-lift property after warming-up is explained. In a super-low load region (a2) including an idle, while setting an inhalation-of-air core phase as the predetermined angle-of-delay phase P2, an inhalation-of-air actuation angle is set as the minimum actuation angle, and the close stage of an inlet valve is carried out near the bottom dead point for the valve opening time of an inlet valve behind a top dead center. A pumping loss is reduced, in order that an inlet valve may open by this after a piston top face is not exposed to a depression at engine manifold from a top dead center, but a piston displaces to some extent and the inside of a cylinder serves as negative pressure while residual gas is reduced. Moreover, since the inhalation-of-air actuation angle is minimized, while friction is reduced, gas floating is strengthened and atomization of a fuel is promoted. Consequently, improvement in fuel consumption and the exhaust air engine performance is achieved. The above-mentioned minimum actuation angle is for example, 80-90-degreeCA, and the above-mentioned angle-of-delay phase P2 is a value by the side of the angle of delay from at least 90-degreeATDC.
[0025] In an inside load region (c), in order to make an inlet-valve valve opening time into a top dead center front in order to mainly aim at the formation of pumping-loss reduction by the increment in residual gas, the combustion improvement by hot residual gas, etc., and to mainly aim at reduction of a pumping loss by reduction-ization of an inhalation air content (charging efficiency), an inlet-valve close stage is made into a bottom dead point front. Then, while setting it as a larger predetermined small actuation angle than the above-mentioned minimum actuation angle, an inhalation-of-air core phase is set as the maximum tooth-lead-angle phase P5.
[0026] From the inside load region (c) of the above, in order to attain improvement of combustion and reduction-ization of residual gas, an inhalation-of-air actuation angle is set as the value between the above-mentioned minimum actuation angle and a small actuation angle, and an inhalation-of-air core phase is mainly set as the predetermined tooth-lead-angle phase P4 in a low loading region with few inhalation air contents (b). Thereby, improvement in fuel consumption is achieved by reduction-ization of the pumping loss accompanying the increment in an effective compression ratio. The above-mentioned tooth-lead-angle phase P4 is a value by the side of the angle of delay from the above-mentioned maximum tooth-lead-angle phase P5, and is a value by the side of a tooth lead angle from 90-degreeATDC.
[0027] Full admission region (d) In order to mainly raise a charging efficiency, while setting an inhalation-of-air core phase as the predetermined cadaveric position phase P3 or its near, an inhalation-of-air actuation angle is made to increase with the increment in an engine rotational frequency in - (f). For example, in full admission and a low-speed area (d), the valve opening time (IVO) of an inlet valve is made into an abbreviation top dead center, and the close stage (IVC) of an inlet valve is set up behind a bottom dead point. The above-mentioned cadaveric position phase P3 is for example, about 90-degreeATDC.
[0028] On the other hand, like [at the time of cold machine start up], since catalyst warming up is imperfection, in order to aim at the exhaust air defecation and emission temperature lifting by combustion improvement, the minimum actuation angle and an inhalation-of-air core phase are set as the maximum angle-of-delay phase P1 for an inhalation-of-air actuation angle, and the angle of delay of the IVO is carried out in super-low load regions [in / in engine temperature / the cold machine condition below a predetermined value] (a1), such as an idle, more nearly substantially than a top dead center. While atomization of the fuel by gas floating consolidation is promoted by such setting out, after developing the negative pressure in a cylinder enough by angle-of-delay-ization of IVO, gas [inlet valve] floating at the time of open [of open Lycium chinense, a next door, and an inlet valve] is strengthened further.
[0029] In addition, although not illustrated, since combustion may get worse if it is made the same as that of the lift property (b) of standby, and (c), it is necessary to be making it setting out of the lift property (d) of a low speed and a full admission region, and abbreviation identitas etc. in low and the inside load region in a cold machine condition.

[0030] In addition, unlike setting out of drawing 8 (a2), in the time of an engine cold machine, the actuation angle of the inlet valve in the super-low load regions at the time of engine start up etc. may be set up so that it may become smaller than the warming-up back. In this case, at the time of cold machine start up, since an actuation angle becomes small as compared with the time of warming-up, gas floating is strengthened and combustion is improved. On the other hand, at the time of pre-heating start up, since an actuation angle becomes large relatively as compared with the time of cold machine start up and inhalation resistance is controlled, improvement in the fuel consumption engine performance can be aimed at.
[0031] Next, with reference to drawing 9 -11, the case where acceleration is performed from each operational status is examined. In addition, L1 in drawing expresses the criteria property corresponding to criteria setting out of the inhalation-of-air actuation angle in the operational status before acceleration, and an inhalation-of-air core phase. Moreover, the table of the property in the condition of L4 having turned to the target phase the property in the condition of L3 having turned only the inhalation-of-air actuation angle to the target actuation angle for the target property corresponding to a target actuation angle and a target phase to the above-mentioned criteria property L1 in L2, and carrying out specified quantity change, to the criteria property L1, and carrying out specified quantity change only of the inhalation-of-air core phase is carried out, respectively.
[0032] First, drawing 9 is referred to and the acceleration from the super-low load region at the time of a cold machine (cold machine idle state) is considered. In the cold machine idle state, as mentioned above, the inhalation-of-air core phase is set as the maximum angle-of-delay phase P1. Therefore, when only an inhalation-of-air actuation angle is made to increase, there is a possibility that torque may decrease temporarily, by the reasons of an inlet-valve close stage becoming late too much in a super-low load region. For example, in a revolution region lower than the 1st rotational frequency N1 shown in drawing 9 , since the torque of the property L3 after the increment in an actuation angle is low rather than the criteria property L1, when only an actuation angle is changed, torque will decrease temporarily.
[0033] On the other hand, even if it carries out the tooth lead angle only of the inhalation-of-air core phase at the time of the acceleration from such a super-low load, torque goes in the increment direction certainly. Therefore, at the time of the acceleration from such a super-low load and a super-low revolution region, tooth-lead-angle-ization of the inhalation-of-air core phase by the phase modification device 20 is performed preferentially. That is, only the phase modification device 20 is driven, or it controls so that the amount of modification of the inhalation-of-air core phase by the phase modification device 20 becomes larger enough than the amount of modification of the actuation angle by the actuation angle modification device 10. Thereby, the torque in this acceleration transient will go in the increment direction certainly, and can avoid torque lowering of a transient certainly.
[0034] By the way, the criteria setting out (the minimum actuation angle and the maximum angle-of-delay phase) L1 of this cold machine idle state is the object which mainly aims at a combustion improvement, and is used also in the low revolution region where a rotational frequency is to some extent higher than a super-low revolution region. However, in order that inhalation time amount may decrease, even if it carries out the tooth lead angle only of the inhalation-of-air core phase, full admission torque cannot be made to increase effectively on the same actuation square, if an engine rotational frequency becomes high. therefore, in a super-low revolution region (for example, with a rotational frequency [2nd / N] of two or less which torque reverses in the property L3 of an actuation angle increasing state and the property L4 of a phase tooth-lead-angle condition which are shown in drawing 9 revolution region) Torque can be made to increase most efficiently by carrying out the tooth lead angle of the inhalation-of-air core phase preferentially, as mentioned above, and making an inhalation-of-air actuation angle increase preferentially in a low revolution region (for example, revolution region exceeding the 2nd rotational frequency N2).
[0035] Next, the case where acceleration is performed from a super-low load region in the condition after warming-up with reference to drawing 10 is considered. In the super-low load region after warming-up, in order to mainly control inhalation resistance and to aim at improvement in fuel consumption, as mentioned above, the inhalation-of-air core phase is set as the angle-of-delay phase P2 after warming-up which carried out the tooth lead angle rather than the maximum angle-of-delay

phase P1. That is, in order to mainly raise an effective compression ratio and to aim at an improvement of combustion, the inlet-valve close stage is made to tooth-lead-angle-ize rather than the time of a cold machine. Therefore, if the tooth lead angle only of the inhalation-of-air core phase is carried out, an effective compression ratio and a charging efficiency can fall and torque cannot be made to increase effectively. Then, torque can be made to increase efficiently by making an inhalation-of-air actuation angle increase preferentially at the time of the acceleration from the super-low load region after such warming-up.

[0036] Thus, even if it is the case where acceleration is performed from the same load region, based on either [at least] an engine rotational frequency or engine temperature (a cold machine or warming-up), by making either the actuation angle modification device 10 or the phase modification device 20 drive preferentially, torque can be made to increase efficiently and improvement in operability can be aimed at.

[0037] Next, the case where acceleration is performed from a low loading region in the condition after warming-up with reference to drawing 11 is considered. At the time of the acceleration from a low loading region, even if it makes an actuation angle increase in drawing 11 so that clearly from the both sides of properties L3 and L4 having torque higher than the criteria property L1 and carries out the angle of delay of the phase, torque increases. However, torque can be made to increase efficiently irrespective of an engine rotational frequency in drawing 11 , by giving priority to the increment in the inhalation-of-air actuation angle by the actuation angle modification device 10 over angle-of-delay-ization of the inhalation-of-air core phase by the phase modification device 20 so that clearly from the property L3 of torque of an actuation angle increasing state being always higher than the property L4 of an angle-of-lag condition.

[0038] In addition, about the acceleration from an inside load region like drawing 8 (c), although not illustrated, since there is a possibility that IVO may become early too much and an inlet valve and a piston may approach dramatically when priority is given to the increment in an actuation angle, angle-of-delay-ization of the inhalation-of-air core phase by the phase modification device 20 is performed preferentially preferably.

[0039] As mentioned above, since the phase modification device 20 is considered as the electromotive configuration, it becomes possible to change an inhalation-of-air core phase promptly irrespective of engine temperature (at the time [At the time of a cold machine] of - elevated temperature). That is, a phase can be promptly changed to the hydraulic drive which is easy to produce phase modification delay also at the time of a cold machine at the time of a cold machine. From this, at the time of cold machine start up, an inlet-valve valve opening time can be made to be able to angle-of-delay-ize substantially, gas floating can be strengthened, and improvement of combustion and exhaust air defecation can be attained. Moreover, by carrying out the tooth lead angle of a little inhalation-of-air core phase after warming-up, inhalation resistance is reduced and improvement in fuel consumption is aimed at. It becomes possible from this to reconcile defecation of the exhaust air at the time of a cold machine, and the improvement in fuel consumption after warming-up on high level.

[0040] Moreover, since the actuation angle modification device 10 is also considered as the electromotive configuration, while being able to set up adjustable width of face greatly enough for example, with 80-280-degreeCA, an inhalation-of-air actuation angle can be changed certainly and promptly at the time of cold machine start up and a super-low revolution. That is, it becomes possible by adopting such an electromotive actuation angle modification device 10 to make the actuation angle modification device 10 drive preferentially also by the low-speed area. Moreover, an actuation angle can be made to increase promptly irrespective of engine temperature (the time of a cold machine, or after warming-up). For this reason, it becomes it is possible to set up the minimum actuation angle small enough as compared with the configuration of the hydraulic-drive type which is easy to produce the increment delay of an actuation angle at the time of a cold machine, and possible to make gas floating at the time of cold machine start up strengthen effectively from this, to improve combustion, and to attain defecation of the further exhaust air.

[0041] Thus, even if it is in the middle of an acceleration transition stage as mentioned above since both modification devices 10 and 20 are made electromotive, it becomes controllable [which switches the priority of both the modification devices 10 and 20].

[0042] By the way, in a configuration of detecting the actual measurement (real core phase) of the main phase of the inhalation-of-air driving shaft 3 over whenever [crank angle], based on the detecting signal from the include-angle detection sensor 31 of the inhalation-of-air driving shaft 3, an inhalation-of-air core phase will be detected for every revolution of the inhalation-of-air driving shaft 3 like this operation gestalt. On the other hand, based on the detecting signal from the include-angle detection sensor 32 of a control axis 13, in a configuration of detecting the actual measurement (real actuation angle) of an inhalation-of-air actuation angle, the detection spacing is free and can detect a real actuation angle to the timing of arbitration. Therefore, in accordance with the timing as which a real inhalation-of-air phase is detected, by detecting a real actuation angle, based on the real inhalation-of-air phase and real actuation angle which are detected at a coincidence term, setting out of the desired value of an inhalation-of-air actuation angle and an inhalation-of-air core phase etc. can be controlled, and the control precision improves.
[0043] Such a control flow is explained in full detail with reference to the flow chart of drawing 12 . In S11, if a real inhalation-of-air phase is detected based on the detecting signal from the include-angle detection sensor 31 of the inhalation-of-air driving shaft 3, it will progress to S12 and a real actuation angle will be detected based on the detecting signal of the include-angle detection sensor 32 of a control axis 13. In S13 continuing, if judged with it being in an acceleration condition, it will progress to S14 and a cold machine condition or the warming-up back will be judged based on engine temperature etc. The case at the time of a cold machine, it progresses to S16 and a super-low revolution region or a low revolution region is judged based on an engine rotational frequency. In the case of a super-low revolution region, it progresses to S17 and control which drives the phase modification device 20 preferentially is performed. On the other hand, in the case of a low revolution region, it progresses S18, and control which drives the actuation angle modification device 10 preferentially is performed.
[0044] Moreover, when judged with the warming-up back in S14, it progresses to S15 and judges whether an inlet-valve valve opening time (IVO) is too early. When too early, it progresses to above S17 and control which drives the phase modification device 20 preferentially is performed. When judged with it being comparatively late, it judges whether it progressed to above S16, and has responded to the engine rotational frequency, and the modification devices 10 and 20 of a gap are driven preferentially.

[Translation done.]

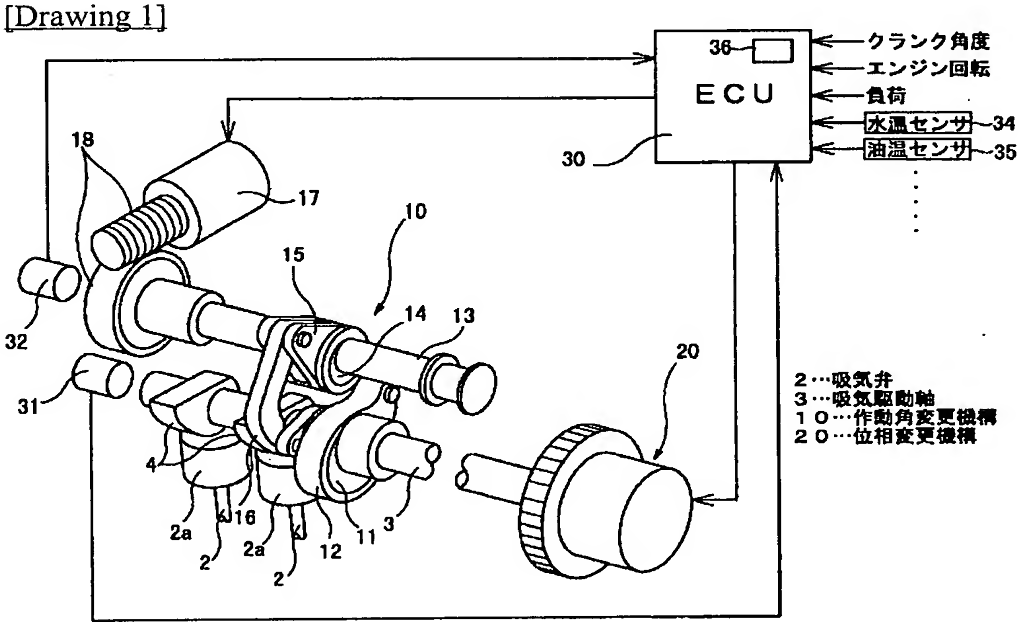
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The outline perspective view showing the adjustable moving valve mechanism concerning 1 operation gestalt of this invention.
[Drawing 2] Drawing corresponding to a cross section showing the actuation angle modification device of the above-mentioned good fluctuation valve gear.
[Drawing 3] The sectional view showing the phase modification device of the above-mentioned good fluctuation valve gear.
[Drawing 4] The flow chart which shows setting out and the control flow of an inhalation-of-air actuation angle and an inhalation-of-air core phase.
[Drawing 5] Property drawing showing the inhalation-of-air valve-lift property over the engine temperature in a super-low load region.
[Drawing 6] Property drawing showing the inhalation-of-air actuation angle over the engine temperature in a super-low load region.
[Drawing 7] Property drawing showing the inhalation-of-air actuation angle over the engine temperature in a super-low load region.
[Drawing 8] The explanatory view showing setting out of the inhalation-of-air valve-lift property in various operational status.
[Drawing 9] The explanatory view at the time of the acceleration from a cold machine idle region.
[Drawing 10] The explanatory view at the time of the acceleration from a warming-up idle region.
[Drawing 11] The explanatory view at the time of the acceleration from a warming-up low loading region.
[Drawing 12] The flow chart which shows setting out and the control flow of the priority of a modification device.
[Description of Notations]
2 -- Inlet valve
3 -- Inhalation-of-air driving shaft
4 -- Splash cam
10 -- Actuation angle modification device
11 -- Actuation cam
12 -- Ring-like link
13 -- Control axis
14 -- Control cam
15 -- Rocker arm
16 -- Rod-like link
20 -- Phase modification device

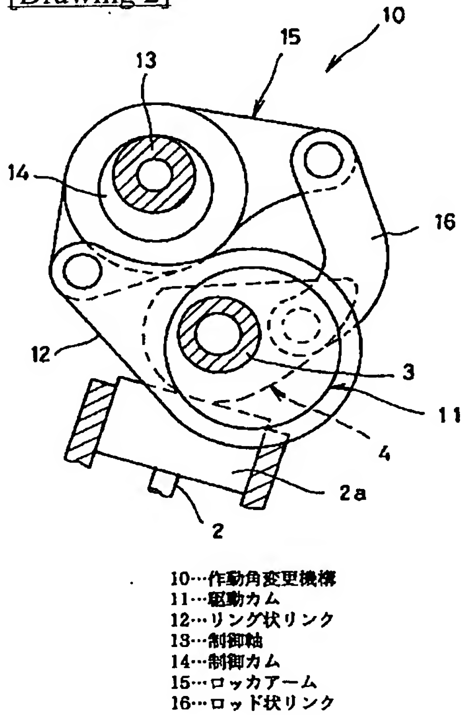
[Translation done.]

DRAWINGS

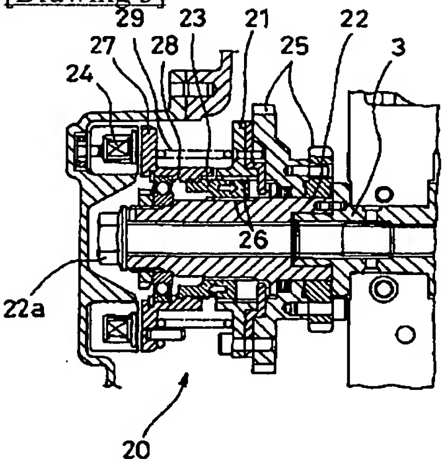
[Drawing 1]



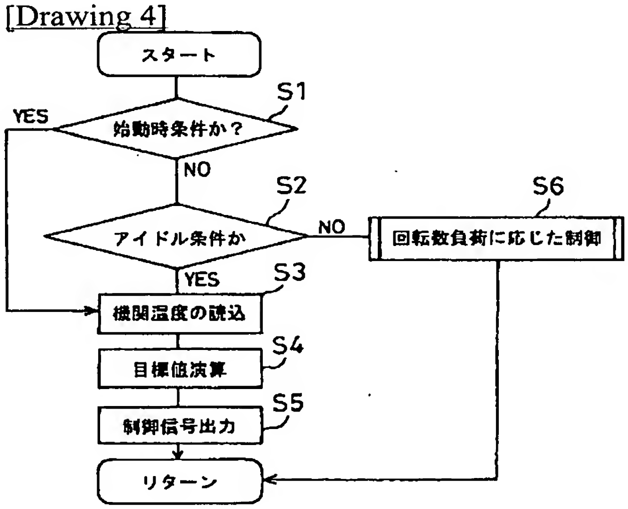
[Drawing 2]



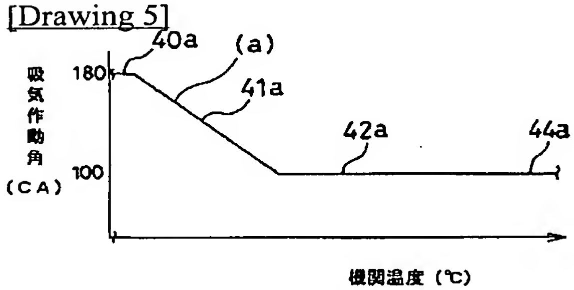
[Drawing 3]



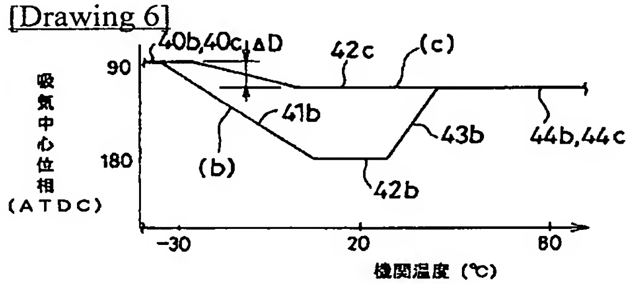
[Drawing 4]



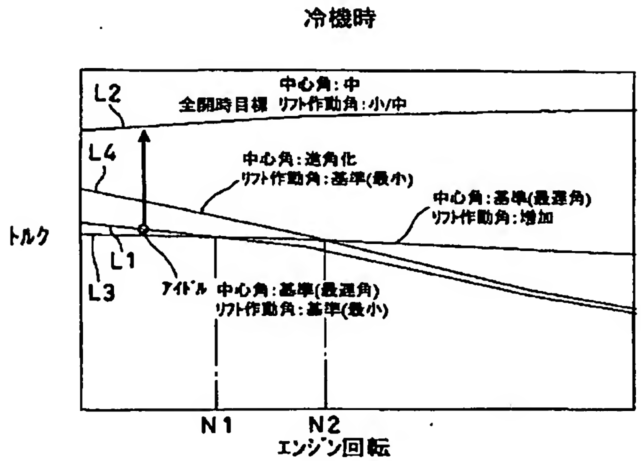
[Drawing 5]



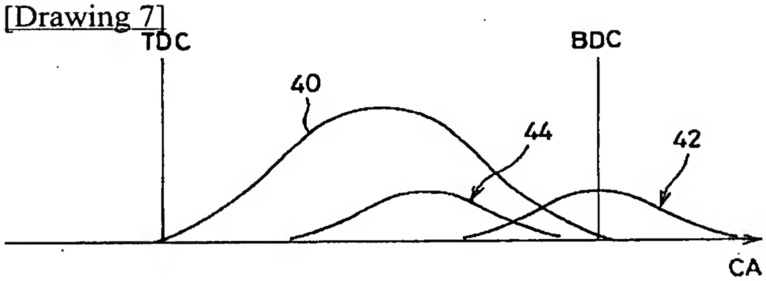
[Drawing 6]



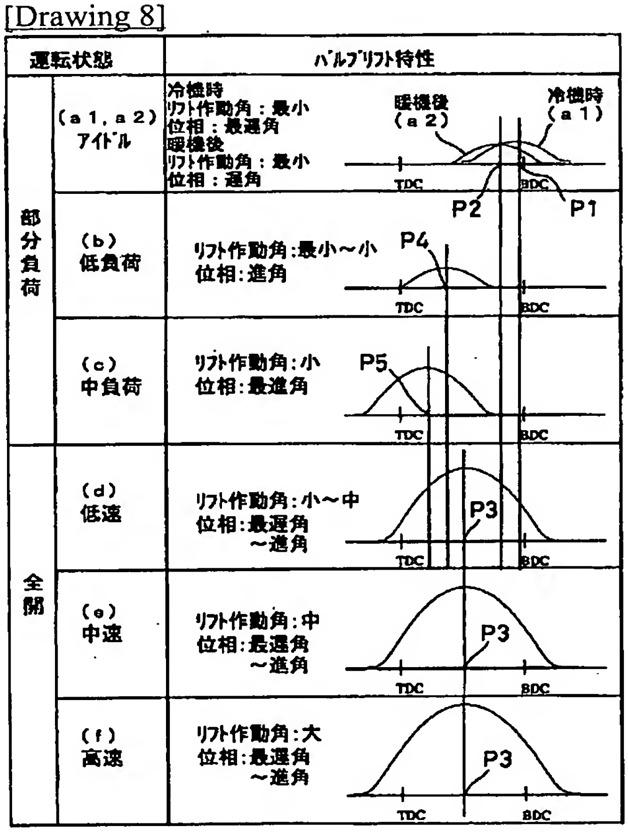
[Drawing 9]



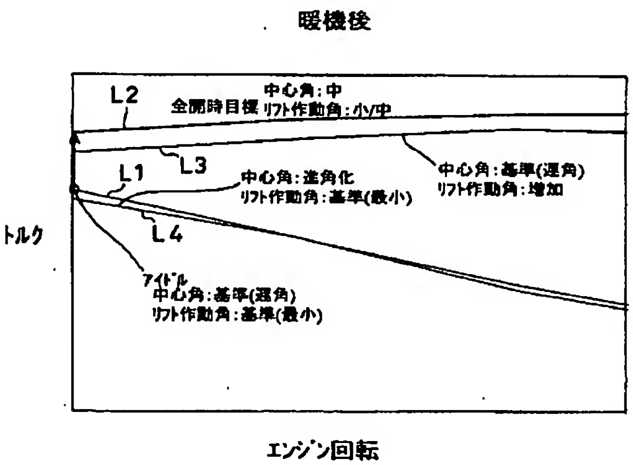
[Drawing 7]



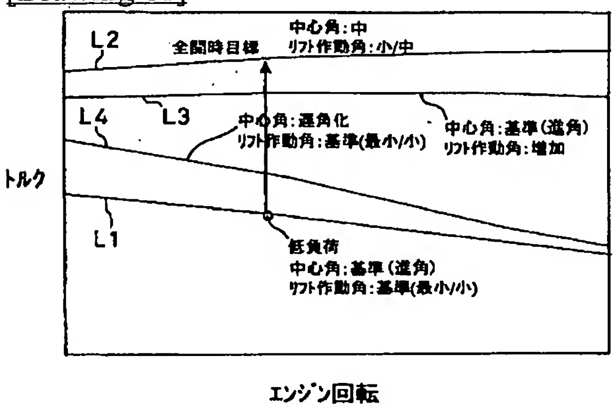
[Drawing 8]



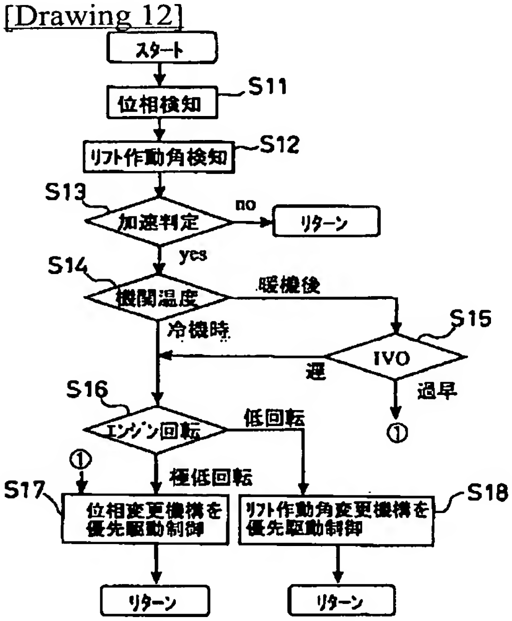
[Drawing 10]



[Drawing 11]



[Drawing 12]



[Translation done.]

TSN 2003-74832
TY 23
31例1

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（A）　(11)特許出願公開番号
特開2003－269124
（P2003－269124A）
(43)公開日　平成15年9月25日(2003.9.25)

(51)Int.Cl.⁷	識別記号	F I	テーマコード゛(参考)
F０１L　13/00	３０１	F０１L　13/00	３０１Y　３G０１８
			３０１K　３G０９２
1/34		1/34	C
F０２D　13/02		F０２D　13/02	H

審査請求　有　　請求項の数12　ＯＬ　（全 10 頁）

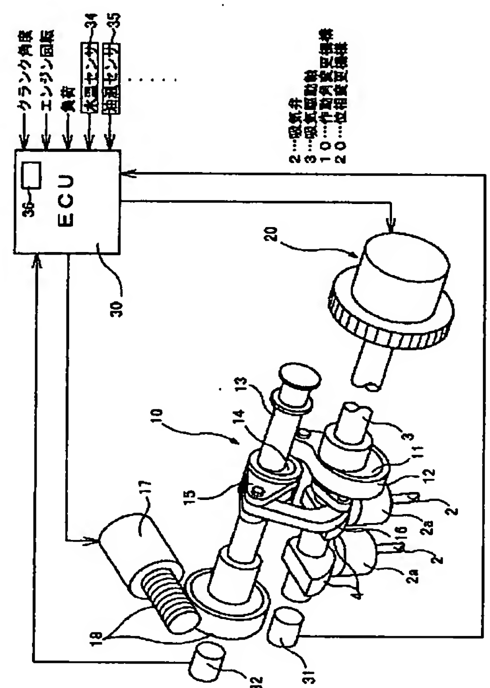
(21)出願番号　特願2002－71226(P2002－71226)
(22)出願日　平成14年3月15日(2002.3.15)

(71)出願人　000003997
日産自動車株式会社
神奈川県横浜市神奈川区宝町２番地
(72)発明者　三浦　創
神奈川県横浜市神奈川区宝町２番地　日産自動車株式会社内
(74)代理人　100062199
弁理士　志賀　富士弥　（外３名）

最終頁に続く

(54)【発明の名称】　内燃機関の可変動弁装置

(57)【要約】
【課題】　機関温度が冷機時よりも更に低い極低温時には、エンジンオイルの粘度が高いことなどに起因して、機関のフリクションが高く、良好に機関を始動することが困難である。
【解決手段】　吸気弁の吸気作動角を変更可能な作動角変更機構１０と、吸気中心位相を変更可能な位相変更機構２０と、機関温度を推定する手段３６と、を有する。アイドルを含む極低温負荷域では、極低温時の吸気作動角を、少なくとも冷機時の吸気作動角よりも大きい約１８０°ＣＡとし、吸気中心位相を約９０°ＡＴＤＣとする。



【特許請求の範囲】

【請求項１】　吸気弁の吸気作動角を変更可能な作動角変更機構と、上記吸気作動角の吸気中心位相を変更可能な位相変更機構と、機関温度を推定する機関温度推定手段と、を有する内燃機関の可変動弁装置において、
少なくともアイドルを含む極低負荷域では、上記機関温度が冷機時よりも更に低い極低温時の吸気作動角を、少なくとも上記冷機時の吸気作動角よりも大きくすることを特徴とする内燃機関の可変動弁装置。

【請求項２】　上記極低負荷域における上記極低温時には、上記吸気作動角を約１８０°ＣＡ、上記吸気中心位相を約９０°ＡＴＤＣに設定することを特徴とする請求項１に記載の内燃機関の可変動弁装置。

【請求項３】　上記極低負荷域では、上記冷機時の吸気中心位相を、上記極低温時の吸気中心位相よりも遅角させることを特徴とする請求項２に記載の内燃機関の可変動弁装置。

【請求項４】　上記極低負荷域では、上記暖機後の吸気中心位相を、上記冷機時の吸気中心位相よりも進角させることを特徴とする請求項１～３のいずれかに記載の内燃機関の可変動弁装置。

【請求項５】　上記極低負荷域における上記冷機時には、上記吸気作動角を約９０°ＣＡ、上記吸気中心位相を約１８０°ＡＴＤＣに設定することを特徴とする請求項１～４のいずれかに記載の内燃機関の可変動弁装置。

【請求項６】　機関加速時には、機関回転数又は機関温度の少なくとも一方に基づいて、作動角変更機構又は位相変更機構の一方を優先的に駆動することを特徴とする請求項１～５のいずれかに記載の内燃機関の可変動弁装置。

【請求項７】　機関始動時を含む極低負荷・極低回転域からの加速時において、上記冷機時には位相変更機構を優先的に駆動し、暖機後には作動角変更機構を優先的に駆動することを特徴とする請求項６に記載の内燃機関の可変動弁装置。

【請求項８】　上記冷機時における極低負荷域からの加速時には、極低回転域では位相変更機構を優先的に駆動し、低回転域では作動角変更機構を優先的に駆動することを特徴とする請求項６又は７に記載の内燃機関の可変動弁装置。

【請求項９】　上記位相変更機構及び作動角変更機構の少なくとも一方が電動式であることを特徴とする請求項１～８のいずれかに記載の内燃機関の可変動弁装置。

【請求項１０】　上記極低負荷域における吸気弁の作動角を、冷機時では暖機後よりも小さくすることを特徴とする請求項１～９のいずれかに記載の内燃機関の可変動弁装置。

【請求項１１】　上記作動角変更機構が、上記吸気駆動軸に相対回転可能に外嵌し、吸気弁を開閉駆動する揺動カムと、上記吸気駆動軸に偏心して設けられた駆動カムと、この駆動カムに相対回転可能に外嵌するリング状リンクと、上記吸気駆動軸と平行に配設された制御軸と、この制御軸に偏心して設けられた制御カムと、この制御カムに相対回転可能に外嵌するとともに、一端が上記リング状リンクに連結されたロッカアームと、このロッカアームの他端と上記揺動カムとに連結されたロッド状リンクと、を有することを特徴とする請求項１～１０のいずれかに記載の内燃機関の可変動弁装置。

【請求項１２】　上記吸気駆動軸の回転角度を検出する手段と、
この吸気駆動軸の回転角度に基づいて吸気弁の作動角の実中心位相を検知する位相検知手段と、
上記制御軸の回転角度を検出する手段と、
この制御軸の回転角度に基づいて吸気弁の実作動角を検知する作動角検知手段と、を有し、
上記位相検知手段により実中心位相が検知されるタイミングに合わせて、上記作動角検知手段により実作動角を検知し、これら実中心位相及び実作動角に基づいて、上記吸気作動角及び吸気中心位相の目標値を設定することを特徴とする請求項１１に記載の内燃機関の可変動弁装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、吸気弁の作動角（吸気作動角）を変更可能な作動角変更機構と、吸気弁の作動角の中心位相（吸気中心位相）を変更可能な位相変更機構と、の双方を有する内燃機関の可変動弁装置に関する。

【０００２】

【従来の技術】内燃機関の出力・燃費の向上や排気エミッションの低減化を図るために、吸気弁や排気弁の開閉特性（バルブリフト特性）を変更する種々の可変動弁装置が従来より提案されている。例えば、特開２０００－１８０５６号公報には、吸気弁のバルブリフト量及び作動角を２段階に変更可能なバルブリフト量変更機構と、吸気弁の作動角の中心位相を連続的に変更可能なバルブタイミング変更機構と、を併用した可変動弁装置が開示されている。

【０００３】

【発明が解決しようとする課題】このような可変動弁装置において、燃費の向上や排気エミッションの低下を図る面では、アイドルを含む極低負荷域に吸気作動角を小さくした方が良い。しかしながら、寒冷地等で機関温度が－２０℃を越えて低下するような極低温時には、主にエンジンオイルの粘度の増加に起因して機関のフリクションが非常に高くなる。従って、上記の極低負荷域で、かつ極低温時の状況において、仮に上述したように吸気作動角を小さくすると、上記機関フリクションに抗して機関を始動するのに充分な機関トルクを得ることができず、機関始動性の低下を招くおそれがある。本発明はこ

のような課題に鑑みてなされたものである。

【０００４】

【課題を解決するための手段】本発明に係る内燃機関の可変動弁装置は、吸気弁の吸気作動角を変更可能な作動角変更機構と、上記吸気作動角の吸気中心位相を変更可能な位相変更機構と、機関温度を推定する機関温度推定手段と、を有している。そして、少なくともアイドルを含む極低負荷域では、上記機関温度が冷機時よりも更に低い極低温時の吸気作動角を、少なくとも上記冷機時の吸気作動角よりも大きくする。典型的には、上記極低負荷域における上記極低温時に、上記吸気作動角を約１８０°ＣＡ（クランク角度）、上記吸気中心位相を約９０°ＡＴＤＣ（上死点後の角度）に設定する。

【０００５】また、同一負荷域からの加速時であっても、機関回転数又は機関温度に基づいて、優先的に（先に）駆動する変更機構を切換制御することにより、加速時におけるトルクの落ち込みを防止して、機関運転性能の向上を図ることが可能となる。

【０００６】

【発明の効果】本発明によれば、極低負荷域には、機関温度に応じて吸気作動角が適切に調整される。つまり、極低温時には吸気作動角を相対的に大きくすることにより良好な機関始動性を確保する一方、少なくとも冷機時を含む極低温時以外の状況のときには、吸気作動角を相対的に小さくすることにより、排気エミッションの改善や燃費の向上を図ることができる。

【０００７】

【発明の実施の形態】以下、本発明の好ましい実施の形態を図面を参照して詳細に説明する。

【０００８】図１は、本発明の一実施形態に係る可変動弁装置を示している。各気筒には一対の吸気弁２が設けられ、これら吸気弁２の上方には中空状の吸気駆動軸３が気筒列方向に延在している。吸気駆動軸３には、吸気弁２のバルブリフタ２ａに当接して吸気弁２を開閉駆動する揺動カム４が相対回転可能に外嵌している。

【０００９】吸気駆動軸３と揺動カム４との間には、吸気弁２の作動角である吸気作動角及びバルブリフト量を連続的に変更する電動式の作動角変更機構１０が設けられている。吸気駆動軸３の一端部には、図外のクランクシャフトに対する吸気駆動軸３の位相を変化させることにより、上記吸気作動角の中心位相である吸気中心位相を連続的に変更する電動式の位相変更機構２０が配設されている。

【００１０】作動角変更機構１０は、図１及び図２に示すように、吸気駆動軸３に偏心して固定的に設けられる円形の駆動カム１１と、この駆動カム１１に相対回転可能に外嵌するリング状リンク１２と、吸気駆動軸３と略平行に気筒列方向へ延びる制御軸１３と、この制御軸１３に偏心して固定的に設けられた円形の制御カム１４と、この制御カム１４に相対回転可能に外嵌するとともに、一端がリング状リンク１２の先端に連結されたロッカアーム１５と、このロッカアーム１５の他端と揺動カム４とに連結されたロッド状リンク１６と、を有している。制御軸１３は、電動アクチュエータ１７によりギヤ列１８を介して所定の制御範囲内で回転駆動される。

【００１１】上記の構成により、クランクシャフトに連動して吸気駆動軸３が回転すると、駆動カム１１を介してリング状リンク１２がほぼ並進移動するとともに、ロッカアーム１５が制御カム１４の軸心周りに揺動し、ロッド状リンク１６を介して揺動カム４が揺動して吸気弁２が開閉駆動される。また、制御軸１３の回転角度を変化させることにより、ロッカアーム１５の揺動中心となる制御カム１４の軸心位置が変化して揺動カム４の姿勢が変化する。これにより、吸気中心位相が略一定のままで、吸気作動角及びバルブリフト量が連続的に変化する。

【００１２】このような作動角変更機構１０は、駆動カム１１の軸受部分や制御カム１４の軸受部分等の各部材の連結部分が面接触となっているため、潤滑が行い易く、耐久性，信頼性に優れている。また、吸気弁２を駆動する揺動カム４が吸気駆動軸３と同軸上に配置されているため、例えば揺動カムを吸気駆動軸３とは異なる別の支軸で支持するような構成に比して、制御精度に優れているとともに、装置自体がコンパクトなものとなり、機関搭載性に優れいている。特に直動式の動弁系には、大きなレイアウトの変更を加えることなく適用することができる。更に、リターンスプリング等の付勢手段を敢えて必要としないために、動弁系のフリクションも低く抑制される。

【００１３】エンジンコントロールユニットとしてのＥＣＵ３０は、角度検出センサ３１，３２から検出される吸気駆動軸３及び制御軸１３の角度の他、各種センサ等から検出又は推定されるクランク角度，機関回転数，負荷，機関温度等の機関運転条件に基づいて、燃料噴射制御や点火時期制御などの一般的なエンジン制御を行う他、後述するように吸気弁２の吸気作動角及び吸気中心位相を変更・制御する。また、ＥＣＵ３０は、周知の水温センサ３４により検出される冷却水温、及び周知の油温センサ３５により検出される油温、の少なくとも一方に基づいて、機関温度（油水温）を推定する機関温度推定手段３６を含んでおり、この機関温度に基づいて、後述する機関の暖機状態、すなわち極低温時、冷機時、又は暖機後であるかを正確に判断することができる。

【００１４】図３は、電動式の位相変更機構２０を示している。この位相変更機構２０は、クランクシャフトと同期して回転するカムスプロケット２５に固定され、このカムスプロケット２５と一体的に回転する第１回転体２１と、ボルト２２ａにより吸気駆動軸３の一端に固定され、この吸気駆動軸３と一体的に回転する第２回転体２２と、ヘリカルスプライン２６により第１回転体２１

5

の内周面と第２回転体２２の外周面とに噛合する筒状の中間ギア２３と、を有している。この中間ギア２３には３条ネジ２８を介してドラム２７が連結されており、このドラム２７と中間ギア２３との間にねじりスプリング２９が介装されている。中間ギア２３は、ねじりスプリング２９によって遅角方向（図３の左方向）へ付勢されており、電磁リターダ２４に電圧を印加して磁力を発生すると、ドラム２７及び３条ネジ２８を介して進角方向（図３の右方向）へ動かされる。この中間ギア２３の軸方向位置に応じて、回転体２１，２２の相対位相が変化して、クランクシャフトに対する吸気駆動軸３の位相が変化する。上記の電磁リターダ２４は、上述したＥＣＵ３０からの制御信号により機関運転状態に応じて駆動制御される。

【００１５】図４は、本実施形態の要部をなす機関始動時及び極低負荷域における吸気作動角及び吸気中心位相の設定・制御の流れを示すフローチャートで、このルーチンはＥＣＵ３０により実行される。Ｓ（ステップ）１において、機関始動時であると判定されるか、あるいはＳ２のアイドル判定によりアイドルを含む極低負荷域であると判定されると、Ｓ３へ進み、機関温度推定手段３６により推定される機関温度を読み込む。ＥＣＵ３０のメモリには、後述する図５（ａ）及び図６（ｂ）（又は（ｃ））に対応するテーブルやマップが予め記憶されており、Ｓ４では、上記の機関温度に基づいて、これらのテーブルやマップを参照することにより、吸気作動角及び吸気中心位相の目標値を演算する。Ｓ５では、これらの目標値に対応した制御信号を作動角変更機構１０の電動アクチュエータ１７及び位相変更機構２０の電磁リターダ２４へ出力する。これらの制御信号に応じて、吸気作動角及び吸気中心位相が互いに独立して調整される。Ｓ２のアイドル判定が否定されると、Ｓ６へ進み、図示せぬ他のルーチンにより、機関回転数及び機関負荷に応じた吸気作動角及び吸気中心位相の設定・制御が行われる。

【００１６】図５～図７は、上記機関始動時又はアイドルを含む極低負荷域における、機関温度に対する吸気バルブリフト特性を示しており、図５（ａ）は吸気作動角の特性、図６（ｂ）は吸気中心位相の特性を示している。なお、本明細書において、「冷機時」とは、周知のように、暖機前の常温の状態であり、典型的には機関温度が２０℃程度のときである。「極低温時」とは、寒冷地等で機関温度が通常の冷機時よりも更に低く、典型的には－２０℃以下のときである。

【００１７】極低温時には、冷機時に比して、潤滑油としてのエンジンオイルの粘度が高く、機関のフリクションが大きくなるために、このフリクションに抗して少なくともアイドル回転数を維持し得るだけの大きな機関トルクを発生させる必要がある。そこで本実施形態では、このような極低温時に、吸気作動角４０ａを約１８０°ＣＡ、吸気中心位相４０ｂを約９０°ＡＴＤＣに設定している。つまり、吸気バルブリフト特性４０のＩＶＯをＴＤＣ近傍とし、ＩＶＣをＢＤＣ近傍とする。これにより、吸気行程に対応して過不足なく吸気弁が開いた状態、つまりバルブオーバーラップやマイナスオーバーラップがほとんどない状態となり、上記のフリクションに抗してアイドル回転数を維持し得る充分な機関トルクを発生することができる。従って、極低温状態でありながら、良好な機関始動性を確保し、迅速な暖機運転を行うことができる。

6

【００１８】冷機時には、吸気作動角４２ａを最小作動角である約８０°～１００°ＣＡ、好ましくは９０°ＣＡとし、吸気中心位相４２ｂを最遅角位相である１８０°ＡＴＤＣ、つまりＢＤＣ近傍に設定し、吸気バルブリフト特性４２のＩＶＯをＴＤＣよりも大幅に遅角させて、点火時期のリタード限界を拡大することにより、排気温度の上昇を促進し、触媒の昇温時間を短縮して、排気エミッションの改善を図る。また、吸気作動角の最小化により、動弁系のフリクションを最小限に抑制しつつ、ガス流動を強化して燃料の霧化を促進する。

【００１９】暖機後には、吸気作動角４４ａを冷機時と同じ最小作動角としたまま、吸気中心位相４４ｂを冷機時よりも進角し、冷機時に比してポンプ損失を低減して燃費の改善を図る。

【００２０】極低温時から冷機時への過渡期には、機関温度の上昇に伴って、吸気作動角４１ａを徐々に小さくするとともに、吸気中心位相４１ｂを徐々に遅角する。また、冷機時から暖機後への過渡期には、機関温度の上昇に伴って、吸気中心位相４３ｂを徐々に進角する。従って、例えば極低温時に機関を始動し、暖機が完了するまでアイドル運転を続けるような場合に、良好な機関始動性を確保しつつ、機関温度の上昇に伴って吸気作動角及び吸気中心位相を排気エミッションや燃費に有利な特性へと滑らかに変化させていくことができる。

【００２１】上述した図６（ｂ）に示す吸気中心位相の設定例は、図３に示すように、応答性に優れるとともに可変量を充分に大きく設定できる電動式の位相変更機構２０を用いた場合に好適なものである。これに対し、図６（ｃ）に示す吸気中心位相の設定例は、上記の電動式に比して応答性や可変量は劣るもののコスト的に有利な油圧駆動式の位相変更機構を用いた場合などに好適なものである。

【００２２】図６（ｃ）の設定では、冷機時における吸気中心位相の設定値４２ｃを、暖機後の設定値４４ｃと等しくしている点で、図６（ｂ）の設定と異なっている。極低温時及び暖機後の設定値４０ｃ，４４ｃは図６（ｂ）の設定値４０ｂ，４４ｂと同じである。図６（ｃ）の設定によれば、冷機時から暖機後への過渡期に、吸気中心位相を変更する必要がなく、かつ、極低温時から冷機時への過渡期にも、吸気中心位相の変更量Δ

Ｄが非常に少なく済む。このため、上記図６（ｂ）の設定例に比して、冷機時に吸気中心位相の大幅な遅角化による排気エミッションの改善等を図ることはできないが、吸気中心位相の変更が少なくて済むために、例えば極低温時からの機関始動時にも、良好な機関始動性を確保しつつ、機関温度の上昇に応じて吸気中心位相を適切に変更することが可能となる。

【００２３】図８は、様々な運転状態における吸気作動角及び吸気中心位相の一設定例を示している。なお、後述する吸気中心位相Ｐ１～Ｐ５の値は、進角側を正とするとＰ１＜Ｐ２＜Ｐ３＜Ｐ４＜Ｐ５の関係にある。

【００２４】先ず、暖機後のバルブリフト特性について説明する。アイドルを含む極低負荷域（ａ２）では、吸気中心位相を所定の遅角位相Ｐ２に設定するとともに、吸気作動角を最小作動角に設定して、吸気弁の開時期を上死点後、吸気弁の閉時期を下死点近傍とする。これにより、残留ガスが低減されるとともに、ピストン上面が上死点から吸気負圧に晒されず、ある程度ピストンが変位して筒内が負圧となってから吸気弁が開くこととなるために、ポンプ損失が低減される。また、吸気作動角が最小化されているため、フリクションが低減されるとともに、ガス流動が強化され、燃料の霧化が促進される。この結果、燃費及び排気性能の向上が図られる。上記の最小作動角は、例えば８０～９０°ＣＡであり、上記の遅角位相Ｐ２は、少なくとも９０°ＡＴＤＣよりも遅角側の値である。

【００２５】中負荷域（ｃ）では、主に残留ガスの増加によるポンプ損失低減化及び高温の残留ガスによる燃焼改善等を図るために、吸気弁開時期を上死点前とし、かつ、主に吸入空気量（充填効率）の低減化によりポンプ損失の低減を図るために、吸気弁閉時期を下死点前とする。そこで、上記の最小作動角よりも大きい所定の小作動角に設定するとともに、吸気中心位相を最進角位相Ｐ５に設定する。

【００２６】上記の中負荷域（ｃ）より吸入空気量の少ない低負荷域（ｂ）では、主に燃焼の改善及び残留ガスの低減化を図るため、吸気作動角を上記の最小作動角から小作動角の間の値に設定し、かつ、吸気中心位相を所定の進角位相Ｐ４に設定する。これにより、有効圧縮比の増加に伴うポンプ損失の低減化により燃費向上が図られる。上記の進角位相Ｐ４は、上記の最進角位相Ｐ５よりも遅角側の値であり、かつ、９０°ＡＴＤＣよりも進角側の値である。

【００２７】全開域（ｄ）～（ｆ）では、主に充填効率を向上させるため、吸気中心位相を所定の中間位相Ｐ３又はその近傍に設定するとともに、機関回転数の増加に伴って吸気作動角を増加させる。例えば、全開・低速域（ｄ）では、吸気弁の開時期（ＩＶＯ）を略上死点とし、吸気弁の閉時期（ＩＶＣ）を下死点後に設定する。上記の中間位相Ｐ３は、例えば約９０°ＡＴＤＣである。

【００２８】一方、冷機始動時のように、機関温度が所定値以下の冷機状態におけるアイドル等の極低負荷域（ａ１）では、触媒暖機が不十分のため、燃焼改善による排気清浄化及び排温上昇を図るため、吸気作動角を最小作動角、吸気中心位相を最遅角位相Ｐ１に設定し、ＩＶＯを上死点よりも大幅に遅角させる。このような設定により、ガス流動強化による燃料の霧化が促進されるとともに、ＩＶＯの遅角化により筒内負圧を十分発達させた後に吸気弁が開くこととなり、吸気弁の開時における ガス流動が更に強化される。

【００２９】なお、図示していないが、冷機状態における低・中負荷域では、暖機状態のリフト特性（ｂ），（ｃ）と同一にすると燃焼が悪化する可能性があるため、例えば低速・全開域のリフト特性（ｄ）と略同一の設定にする等の必要がある。

【００３０】なお、図８（ａ２）の設定と異なり、機関始動時等の極低負荷域における吸気弁の作動角を、機関冷機時では暖機後よりも小さくなるように設定しても良い。この場合、冷機始動時には、作動角が暖機時に比して小さくなるため、ガス流動が強化されて燃焼が改善される。一方、暖気始動時には、冷機始動時に比して作動角が相対的に大きくなり、吸入抵抗が抑制されるため、燃費性能の向上を図ることができる。

【００３１】次に、図９～１１を参照して、各運転状態から加速を行う場合について検討する。なお、図中のＬ１は、加速前の運転状態における吸気作動角及び吸気中心位相の基準設定に対応した基準特性を表している。また、Ｌ２は、目標作動角及び目標位相に対応した目標特性を、Ｌ３は、上記の基準特性Ｌ１に対して吸気作動角のみを目標作動角へ向けて所定量変化させた状態の特性を、Ｌ４は、基準特性Ｌ１に対して吸気中心位相のみを目標位相へ向けて所定量変化させた状態の特性を、それぞれ表している。

【００３２】先ず、図９を参照して、冷機時における極低負荷域（冷機アイドル状態）からの加速について考察する。冷機アイドル状態では、上述したように吸気中心位相が最遅角位相Ｐ１に設定されている。従って、極低負荷域で、吸気作動角のみを増加させた場合、吸気弁閉時期が過度に遅くなる等の理由で、トルクが一時的に減少するおそれがある。例えば図９に示す第１の回転数Ｎ１よりも低い回転域では、基準特性Ｌ１よりも作動角増加後の特性Ｌ３のトルクが低くなっているため、作動角のみを変化させるとトルクが一時的に減少することとなる。

【００３３】一方、このような極低負荷からの加速時に吸気中心位相のみを進角させても、確実にトルクが増加方向へ向かう。従って、このような極低負荷・極低回転域からの加速時には、位相変更機構２０による吸気中心位相の進角化を優先的に行う。つまり、位相変更機構２

０のみを駆動し、あるいは位相変更機構２０による吸気中心位相の変更量が作動角変更機構１０による作動角の変更量よりも十分に大きくなるように制御する。これにより、この加速過渡時におけるトルクが確実に増加方向へ向かうこととなり、過渡時のトルク低下を確実に回避できる。

【００３４】ところで、この冷機アイドル状態の基準設定（最小作動角及び最遅角位相）Ｌ１は、主に燃焼改善を図る目的で、極低回転域よりも回転数がある程度高い低回転域でも使用される。しかしながら、機関回転数が高くなってくると、同一作動角では吸入時間が減少するため、吸気中心位相のみを進角させても、全開トルクを効果的に増加させることができない。従って、極低回転域（例えば図９に示す作動角増加状態の特性Ｌ３と位相進角状態の特性Ｌ４とでトルクが逆転する第２の回転数Ｎ２以下の回転域）では、上述したように吸気中心位相を優先的に進角させ、低回転域（例えば第２の回転数Ｎ２を越える回転域）では、吸気作動角を優先的に増加させることにより、トルクを最も効率的に増加させることができる。

【００３５】次に、図１０を参照して暖機後の状態で極低負荷域から加速を行う場合について考察する。暖機後の極低負荷域では、主に吸入抵抗を抑制して燃費向上を図るために、上述したように吸気中心位相を最遅角位相Ｐ１よりも進角した暖機後遅角位相Ｐ２に設定している。つまり、主に有効圧縮比を高めて燃焼の改善を図るために、吸気弁閉時期を冷機時よりも進角化させている。従って、仮に吸気中心位相のみを進角させると、有効圧縮比や充填効率が低下し、有効にトルクを増加させることができないことがある。そこで、このような暖機後の極低負荷域からの加速時には、吸気作動角を優先的に増加させることにより、トルクを効率的に増加させることができる。

【００３６】このように、同一負荷域から加速を行う場合であっても、機関回転数又は機関温度（冷機又は暖機）の少なくとも一方に基づいて、作動角変更機構１０又は位相変更機構２０の一方を優先的に駆動させることにより、トルクを効率的に増加させることができ、運転性の向上を図ることができる。

【００３７】次に、図１１を参照して暖機後の状態で低負荷域から加速を行う場合について考察する。低負荷域からの加速時には、図１１において特性Ｌ３及びＬ４の双方とも基準特性Ｌ１よりトルクが高いことから明らかなように、作動角を増加させても位相を遅角させてもトルクは増加する。しかしながら、図１１において、作動角増加状態の特性Ｌ３が位相遅角状態の特性Ｌ４よりも常にトルクが高いことから明らかなように、機関回転数にかかわらず、作動角変更機構１０による吸気作動角の増加を位相変更機構２０による吸気中心位相の遅角化よりも優先させることにより、効率的にトルクを増加させることができる。

【００３８】なお、図示していないが、図８（ｃ）のような中負荷域からの加速については、作動角の増加を優先させるとＩＶＯが過度に早くなって吸気弁とピストンとが非常に近づくおそれがあるので、好ましくは位相変更機構２０による吸気中心位相の遅角化を優先的に行う。

【００３９】以上のように、位相変更機構２０を電動式の構成としているため、機関温度（冷機時・高温時）にかかわらず、吸気中心位相を速やかに変化させることが可能となる。つまり、冷機時に位相変更遅れを生じやすい油圧駆動に対して、冷機時にも迅速に位相を変化させることができる。これより、冷機始動時に吸気弁開時期を大幅に遅角化させてガス流動を強化し、燃焼の改善，排気清浄化を図ることができる。また、暖機後には吸気中心位相を少し進角させることにより、吸入抵抗を低減して燃費の向上を図る。これより、冷機時における排気の清浄化と暖機後の燃費向上とを高いレベルで両立させることが可能となる。

【００４０】また、作動角変更機構１０も電動式の構成としているため、可変幅を例えば８０～２８０°ＣＡと充分に大きく設定できるとともに、冷機始動時や極低回転時においても確実かつ迅速に吸気作動角を変更することができる。つまり、このような電動式の作動角変更機構１０を採用することにより、例えば低速域でも作動角変更機構１０を優先的に駆動させることが可能となる。また、機関温度（冷機時又は暖機後）にかかわらず作動角を迅速に増加させることができる。このため、冷機時に作動角の増加遅れを生じ易い油圧駆動式の構成に比して、最小作動角を十分に小さく設定することが可能で、これより、冷機始動時におけるガス流動を効果的に強化させて燃焼を改善し、更なる排気の清浄化を図ることが可能となる。

【００４１】このように双方の変更機構１０，２０を電動式としているため、上述したように、加速過渡期の途中であっても、両変更機構１０，２０の優先度を切り換えるような制御が可能となる。

【００４２】ところで、この実施形態のように、吸気駆動軸３の角度検出センサ３１からの検出信号に基づいて、クランク角度に対する吸気駆動軸３の中心位相の実測値（実中心位相）を検知する構成の場合、吸気駆動軸３の１回転毎に吸気中心位相が検知されることとなる。一方、制御軸１３の角度検出センサ３２からの検出信号に基づいて、吸気作動角の実測値（実作動角）を検知する構成の場合、その検知間隔は自由であり、任意のタイミングで実作動角を検知することができる。従って、実吸気位相が検知されるタイミングにあわせて、実作動角を検知することにより、同時期に検出される実吸気位相及び実作動角に基づいて吸気作動角，吸気中心位相の目標値の設定等の制御を行うことができ、その制御精度が

向上する。

【００４３】このような制御の流れを、図１２のフローチャートを参照して詳述する。Ｓ１１において、吸気駆動軸３の角度検出センサ３１からの検出信号に基づいて実吸気位相が検知されると、Ｓ１２へ進み、制御軸１３の角度検出センサ３２の検出信号に基づいて、実作動角を検知する。続くＳ１３において、加速状態にあると判定されると、Ｓ１４へ進み、機関温度等に基づいて冷機状態か暖機後かを判定する。冷機時の場合、Ｓ１６へ進み、機関回転数に基づいて極低回転域か低回転域かを判定する。極低回転域の場合、Ｓ１７へ進み、位相変更機構２０を優先的に駆動する制御を行う。一方、低回転域の場合にはＳ１８へ進み、作動角変更機構１０を優先的に駆動する制御を行う。

【００４４】また、Ｓ１４において暖機後と判定された場合、Ｓ１５へ進み、吸気弁開時期（ＩＶＯ）が過度に早いか否かを判定する。過度に早い場合は、上記のＳ１７へ進み、位相変更機構２０を優先的に駆動する制御を行う。比較的遅いと判定された場合、上記のＳ１６へ進み、機関回転数に応じていずれの変更機構１０，２０を優先的に駆動するかを判定する。

【図面の簡単な説明】

【図１】本発明の一実施形態に係る可変動弁装置を示す概略斜視図。

【図２】上記可変動弁装置の作動角変更機構を示す断面対応図。

【図３】上記可変動弁装置の位相変更機構を示す断面図。

【図４】吸気作動角及び吸気中心位相の設定・制御の流れを示すフローチャート。

【図５】極低負荷域における機関温度に対する吸気バルブリフト特性を示す特性図。

【図６】極低負荷域における機関温度に対する吸気作動角を示す特性図。

【図７】極低負荷域における機関温度に対する吸気作動角を示す特性図。

【図８】様々な運転状態における吸気バルブリフト特性の設定を示す説明図。

【図９】冷機アイドル域からの加速時の説明図。

【図１０】暖機アイドル域からの加速時の説明図。

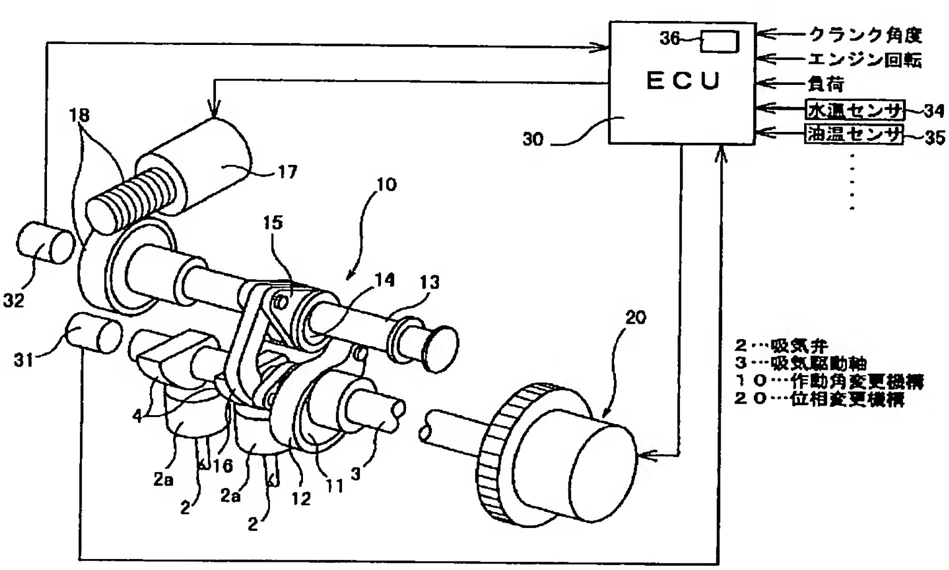
【図１１】暖機低負荷域からの加速時の説明図。

【図１２】変更機構の優先度の設定・制御の流れを示すフローチャート。

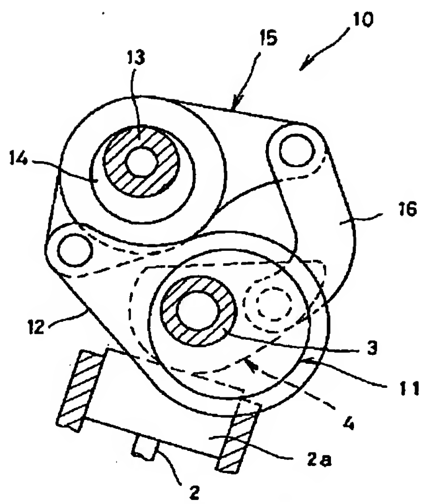
【符号の説明】

２…吸気弁
３…吸気駆動軸
４…揺動カム
１０…作動角変更機構
１１…駆動カム
１２…リング状リンク
１３…制御軸
１４…制御カム
１５…ロッカアーム
１６…ロッド状リンク
２０…位相変更機構

【図１】

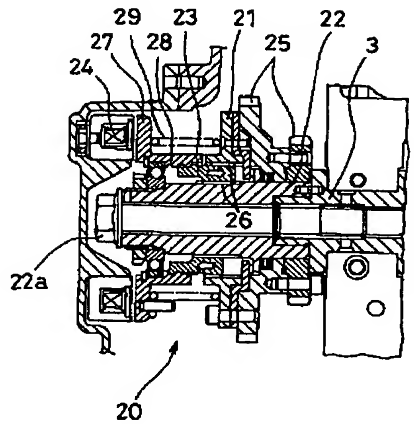


【図２】

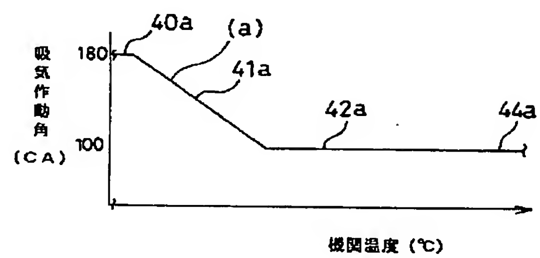


10…作動角変更機構
11…駆動カム
12…リング状リンク
13…制御軸
14…制御カム
15…ロッカアーム
16…ロッド状リンク

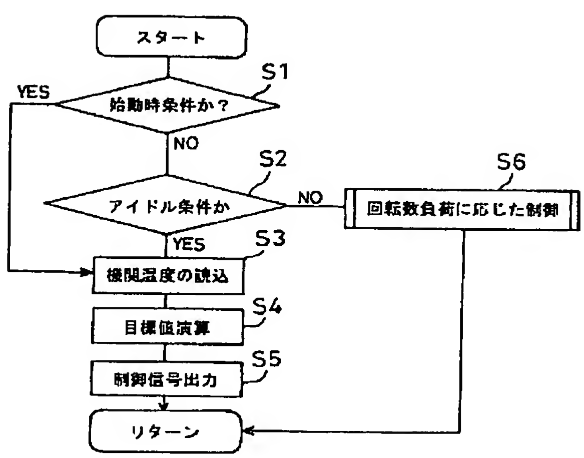
【図３】



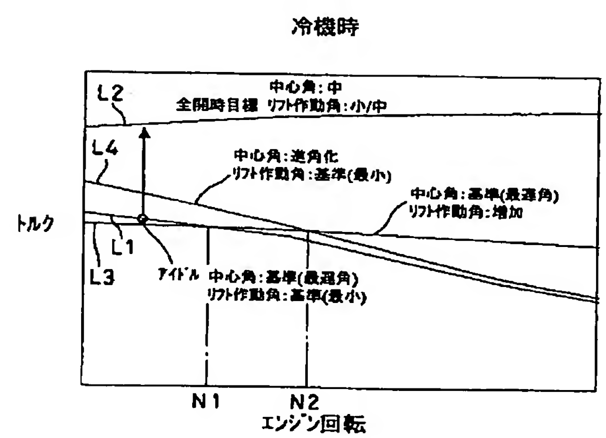
【図５】



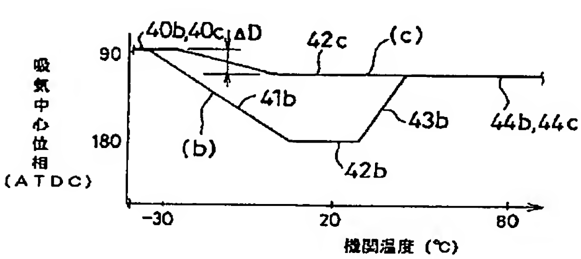
【図４】



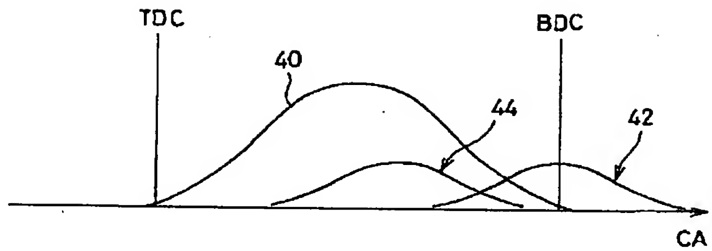
【図９】



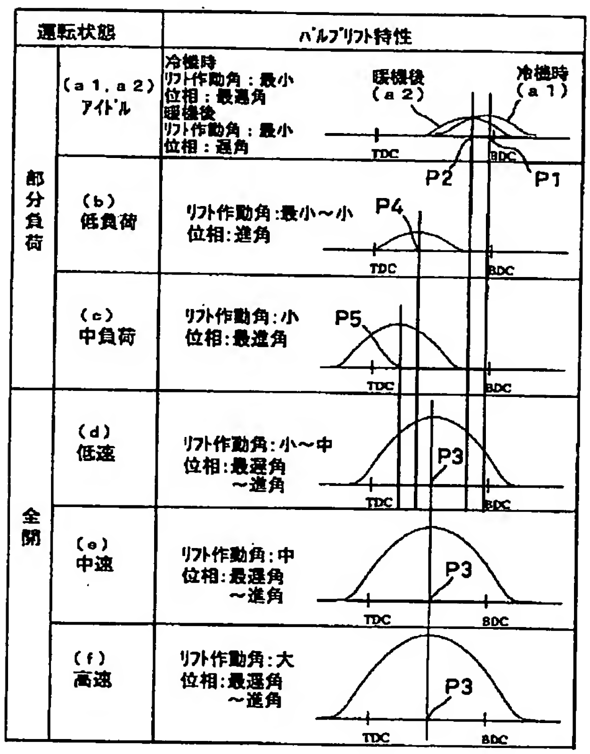
【図６】



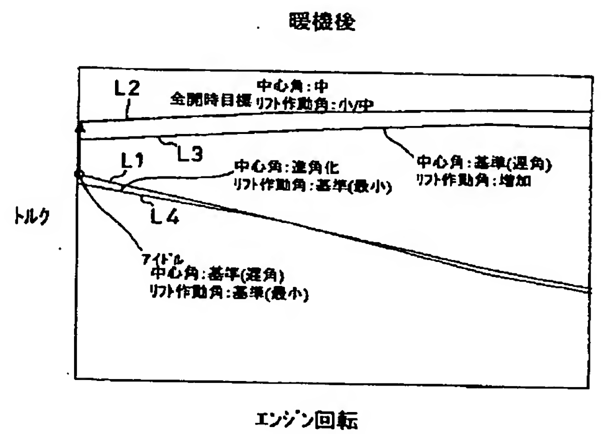
【図７】



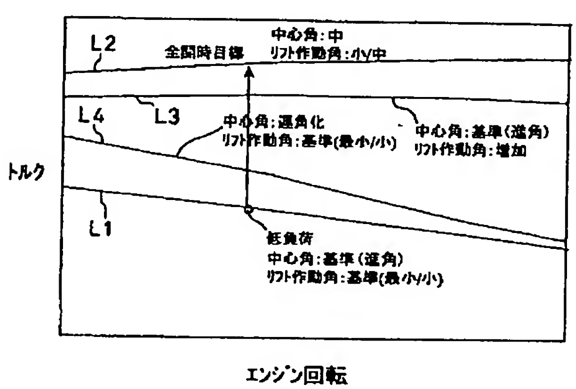
【図８】



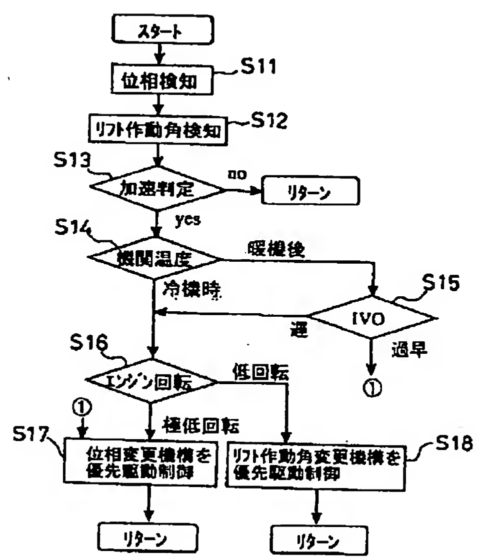
【図１０】



【図１１】



【図１２】



フロントページの続き

Ｆターム(参考) 3G018 AB02 AB16 BA10 BA19 BA34
DA11 DA75 EA02 EA08 EA12
EA13 EA17 EA21 EA22 FA01
FA06 FA07 FA08 FA16 GA07
GA11
3G092 DA03 DA05 DA09 EA01 EA02
EA03 EA04 EA08 FA24 FA25
FA31 FA41 FA42 GA01 GA02
GA03 GA04 GA05 GA06 GA12
HA11Z HE02Z HE03Z HE08Z